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FYI:

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Oil & Gas
From Oklahoma to Ohio, States Take
Measures to Quell Quakes Related to Drilling

By Tripp Baltz, Bebe Raupe and Paul Stinson

July 31 — As production of natural gas and oil has surged in tight shale plays throughout the country, some regions have reported experiencing a significant increase in earthquake activity, possibly attributed to drilling activities.

In an effort to mitigate increased earthquake activity, states such as Arkansas, Colorado, Ohio, Oklahoma and Texas have re-examined regulations, tightening requirements around data reporting, seismic monitoring and information required for permit approval for production and disposal wells. States are also shoring up their authority to shut down wells that are suspected to be linked to recent seismic activity. Additionally, states are imposing restrictions on the location of wells, and several states have imposed moratoriums on drilling in certain areas where seismic activity has increased.

Earthquake Surge in Arkansas

In 2007, north central Arkansas experienced one earthquake with a magnitude 2.5 or greater and in 2008, it recorded two of that size.

In April 2009, four oil and gas wastewater injection wells—ranging from 1 kilometer to 3 kilometers deep—were drilled in the north central area, near the towns of Guy, population 706, and Greenbrier, population 4,706. By the end of 2009, the area recorded 10 earthquakes greater than 2.5, and in 2010, that number was 54.

By the spring of 2011, more than 1,300 total recorded quakes had struck the area since the injection began two years earlier, some of them registering between 4.1 and 4.7 in magnitude.

In March of that year, in response to public concern, the Arkansas Oil & Gas Commission shut down the wells, and the quakes tapered off.

“Shutting down the wells allowed the stresses [on underground faults] to return to normal,” Larry Bengal, director of the commission, told Bloomberg BNA July 17. The earthquakes helped Arkansas discover two previously unknown faults, he said.

One Quake in 2014

Following the shutdown, earthquakes in the Guy-Greenbrier area fell from 725 in 2011 to eight in 2012, Scott Ausbrooks, geohazards supervisor for the Arkansas Geological Survey in Little Rock, told Bloomberg BNA July 14. So far in 2014, the region has recorded one earthquake, he said.

The commission amended its Class II Underground Injection Control program rules following the earthquakes, Bengal said. Class II wells are used to dispose of oil and wastewater by high-pressure, deep injection. The state's moratorium is still in place, Bengal said, adding, “We have no plans to lift it.”

Two of the four wells were owned by Chesapeake Operating Inc., which later sold its wells to BHP Billiton Petroleum (Fayetteville) Inc. A third well was owned by Clarita Operating LLC, a small waste disposal company based in Ada, Okla. Both companies voluntarily shut down injection at the commission's request.

The commission had to force the owner of the fourth well, Deep-Six Water Disposal Services Inc. of Edmond, Okla., to shut down operations, Bengal said.

The commission also imposed a moratorium on wastewater injection in a nearly 1,200-square-mile area of the Fayetteville shale region north of Conway, including near Greenbrier, Guy and Enola, he said. All four wells were located inside the moratorium area, he said.

Recycled or Reused

Today, most of the wastewater generated by oil and gas production inside the moratorium area is either being recycled and reused or trucked to other parts of the state where injection is allowed, Bengal said.

"Because of the hydraulic fracturing methodology, there is a lot more fluid to handle," he said. "There is a lot of water produced in flowback, and the activity level is just much higher."

Additional rules approved by the commission in the aftermath of the Guy-Greenbrier earthquake swarms—which is what intense, localized seismic events are known as—included a requirement requiring distancing between wells and near faults, Bengal said.

"Three of the wells in the Guy-Greenbrier event were in fairly close proximity to one another," he said. "They were all impacting the same fault. One of the problems, obviously, is that you don't know the fault is there."

Location Rejection

Another new rule is a provision allowing the commission to deny a well for a particular location if the potential for seismic activity is high, he said.

"Should we feel there is potential for a fault to be there, and they propose an injection well, we might not allow it in that location,"he said.

"While we can never be 100 percent sure that drilling activities are connected to a seismic event, caution dictates that we take these new steps to protect human health, safety and the environment."
James Zehringer, Ohio Department of Natural Resources

Following the Guy-Greenbrier shutdown, oil and gas companies shared information openly with the state.

"Once the earthquakes started, we asked if we could see their 3-D seismic data," Ausbrooks said. "They confirmed the fault was there. They were focused on the payzone, the area where the hydrocarbons were located, which was several thousand feet above the fault."

"We had a good relationship with the companies early on, but once the lawyers got involved, neither side could talk to one another,"he said.

Several class-action lawsuits were filed by homeowners who accused the companies of triggering earthquakes that caused property damage, Ausbrooks said.

Seismic Data Proprietary

In August 2013 a federal court approved a confidential settlement resolving one consolidated set of the lawsuits (*Hearn v. BHP Billiton Petroleum (Fayetteville) Inc.,* E.D. Ark., No. 4:11-cv-474, 8/29/13; 169 DEN A-2, 8/30/13).

Several more cases are still pending, Bengal said.

Ausbrooks said the state geological survey would like to know as much about what is happening underground as oil and gas producers know from seismic testing.

"That kind of information would be helpful," he said. "But they paid a lot of money to get it, and it's proprietary. It would put them at a disadvantage if they release it and their competitors don't."

Geologists are most concerned about the deeper fault structure, he said. Oil and gas companies are "looking at the middle and upper layers."

"We're concerned about the lower part. Whether there should be a rule or not to require them to share that information, I don't know,"Ausbrooks said.

Colorado Shut Down Well in June

Colorado in late June shut down an injection well near the Greeley-Weld County airport in northeastern Colorado because of its potential link to earthquakes in the area. The Colorado Oil & Gas Conservation Commission allowed the operator of the well, NGL Water Solutions DJ, to resume injection July 18 after making several changes.

The commission also said NGL may have violated its permit by exceeding the volumes it is allowed to inject into the well (139 DEN A-1, 7/21/14).

Leading scientists have closely studied the potential earthquake risks from oil and natural gas development “and concluded it's extremely low,” Jon Haubert, spokesman for Coloradans for Responsible Energy Development, an energy industry group in Denver, told Bloomberg BNA July 10.

The recent Greeley quakes give “scientists and professionals within our state agencies another opportunity to study the issue at hand,”he said.

‘Stringent Environmental Rules.'

Most forms of energy production have the potential to shake the ground, he said. In Colorado, residents “can have assurance that oil and natural gas development is done properly here in our state because of our stringent environmental rules and regulations already in place,”he said.

The first national study of induced seismicity was conducted in Colorado, focusing on a spate of earthquakes that began in March 1962 at the Army's Rocky Mountain Arsenal near Denver after the injection of wastewater into a 12,000-foot injection well, according to the commission. The injection triggered an unusually frequent series of earthquakes nearby from January 1963 to August 1967.

Injection stopped in 1968. In 1990, a report to the EPA established that injection volumes at the arsenal were related to seismic events, demonstrating for the first time a causal link between fluid injection and earthquakes.

Sufficient Safeguards

Colorado now has sufficient safeguards in place to reduce the likelihood of induced seismicity, Stuart Ellsworth, engineering manager with the state oil and gas commission, told Bloomberg BNA July 8.

Commission rules require operators to provide certain information in the well permitting process, he said. The information includes well construction, groundwater and injection zone isolation, fracture gradient—the pressure increase per unit of depth of a well, usually measured in pounds per inch—and maximums for injection rate, volume and pressure.

Permit applications also must include injection zone water quality and potential seismicity associated with fluid injection, Ellsworth said.

Additionally, in September 2011, the commission's UIC permit review process began requiring operators to conduct a review for seismicity in consultation with the Colorado Geological Survey (CGS).

Identify Seismic Potential

The CGS uses geologic maps, the U.S. Geological Survey earthquake database and area-specific knowledge to provide an opinion of seismic potential, the commission said. If historical seismicity has been identified near a Class II underground injection control well, the commission requires the well's operator to define the seismicity potential and the proximity to faults through geologic and geophysical data before the permit can be approved.

Doug Flanders, director of policy and external affairs for the Colorado Oil & Gas Association, told Bloomberg BNA July 10 the association believes the state responded correctly with the NGL shutdown.

Although there have been a few seismic incidents in the state in the past six months, said Flanders, they haven't been observed “like in some other areas of the country.”

New Fracking Rules in Ohio

Like Arkansas, Ohio has made rule changes, implementing new permitting regulations for fracked, horizontally drilled wells after a series of earthquakes in March in Mahoning County.

From January 2011 to February 2012, state researchers recorded more than 100 earthquakes in northeast Ohio that eventually were linked to fracking wastewater pumped deep underground into injection wells near Youngstown.

Since 2012, Ohio has had a moratorium on the disposal of fracking wastewater in counties where seismic activity has been a problem, notably the area around Youngstown.

Also since 2012, Ohio has seen “historic” growth in natural gas production due to fracking, which nearly doubled from 2012 to 2013, according to James Zehringer, the director of the Ohio Department of Natural Resources (ODNR).

The ODNR regulates the oil and gas industry in Ohio, giving it ultimate authority over fracking development statewide.

Unlike the northeast Ohio earthquakes of 2011 and 2012, which were linked to underground injection of fracking wastewater, state geologists concluded that horizontal drilling was the “probable”cause of the March tremors in Mahoning County, said Richard Simmers, ODNR's chief of Division of Oil and Gas Resources Management.

State geologists believe the sand and water injected into the well during the hydraulic fracturing process may have increased pressure on an unknown microfault, Zehringer said.

Further hydraulic fracturing at the site is suspended but the company will be permitted to recover resources from five previously drilled wells located on the pad, according to the department.

First Linkage

The Mahoning County earthquakes were the first time in the state that horizontal drilling had been linked to local quakes, said Simmers, addressing a seminar July 2 on the state's Utica and Marcellus shale oil and gas industry.

In April, following the quakes, the department adopted new permitting rules for drilling sites located near faults or areas of past seismic activity, calling for sensitive seismic monitors to be placed at new fracking operations within three miles of known fault lines or areas that experienced an earthquake greater than magnitude 2.0.

If these monitors detect a seismic event in excess of 1.0 magnitude, mining activities will be paused while the cause is investigated. If the ODNR inquiry reveals a probable connection to the hydraulic fracturing process, all well completion operations will be suspended, according to the department, with a moratorium placed on any drilling within 3 miles of the epicenter.

Drill site operators must provide the monitors, the ODNR said, noting each costs about $20,000 and an average drilling site would probably need five.

Reviewing Issued Permits

The department said that in light of the policy change, it is reviewing previously issued permits for wells that have not yet been drilled. However, the ODNR said it won't require monitoring at wells that already have been drilled.

In addition to on-site monitoring, the ODNR is installing a network of sensitive seismic monitors across the state that will allow researchers to triangulate a tremor event, determine the location of its epicenter and gauge how deep it is.

So far ODNR has set up about 20 solar-powered monitors, said Simmers, noting that this “live interactive monitoring” by seismologists will give the ODNR the ability to determine the cause of future earthquakes.

Monitoring information will also augment data collected by the Ohio Seismic Network, which has been recording seismic data since 1999, he said.

Simmers said information gleaned from the Ohio Seismic Network, coordinated by the ODNR, will be used as part of the new permit application review process.

Oklahoma Study

Concern over the potential relationship between earthquakes and oil and gas exploration remains high in Oklahoma, spurred by unprecedented levels of seismic activity in the state and the release of a July 3 study conducted by seismologists and hydrogeologists from Cornell University, the University of Colorado-Boulder, Columbia University and the USGS, concluding that the recent earthquake surge in the central part of the state is likely attributable to injection of wastewater at a small number of wells.

“If there's any kind of minor anomaly they're told to shut down and fix it because we don't know at this point what is minor.”
Matt Skinner, Oklahoma Corporation Commission

In light of the recent seismicity, the Oklahoma Corporation Commission, which regulates oil and gas activity in the state, is increasing its adoption of a best practices protocol related to the permitting and operation of injection wells.

Also, more robust data reporting requirements for injection wells are set to come into effect in September, the commission said.

Following a 1975-2008 period that produced 56 earthquakes of magnitude 3.0 or greater, Oklahoma has been the site of approximately 538 earthquakes over the last six years, according to Oklahoma Geological Survey data, including 260 so far in 2014—more than double the previous high of 109 set in 2013.

Intensification of Well Permitting Protocols

Matt Skinner, spokesman for the OCC, told Bloomberg BNA July 10 the commission is working toward "intensifying" the use of the "traffic light" approach "to the point where now seismicity concerns are being expressed in any permitting of wells."

Recommended in 2012 by the National Academy of Sciences, the "traffic light"control system would be applied to an instance of induced seismicity. Under a green light, an operator would be free to inject fluids; under a red light, injection would be stopped to allow for further investigation.

A yellow light would allow for low levels of seismicity but would come with added monitoring and mitigation requirements if earthquakes increased in magnitude or frequency, the National Academy of Sciences said.

Skinner likened the approach to a preflight check an airplane would run through, noting that there would be circumstances under which wells wouldn't be cleared for operation if it failed to meet certain standards.

"That's what we're busy developing," said Skinner, referring to the standards. "The intensification effort means that those things—going back to the jetliner analogy—that were considered minor at one time are not considered minor any longer simply because we don't know."

Any well that has a seismicity problem that would be considered minor under the commission's primary mission of water protection is bound to raise a yellow light, Skinner said.

Oklahoma currently can shut down wells because of seismicity, Skinner said, adding that the OCC would need "just a suggestion of a correlation between the well's operation and seismic activity in the area."

Skinner held up the October 2013 shutdown of a disposal well that may have triggered a swarm of earthquakes in Love County a month earlier as a "perfect example."

"Any well that is proposed for right on top of a fault is going to be a red light. We'll oppose it," he said.

Daily Reporting

As part of an effort to achieve a better understanding and improve studies investigating causes of Oklahoma's increased seismicity, a suite of rules requiring energy operators to conduct injection well mechanical integrity testing and other data-gathering activities each day will be brought into effect Sept. 12, according to Skinner, marking the culmination of a process launched by initial March approval by the OCC and approval by the Oklahoma Legislature and signature of Gov. Mary Fallin (R) (53 DEN A-15, 3/19/14).

Additionally, commercial wells will be subject to yearly mechanical integrity tests instead of every five years, and the new OCC regulations will see increased data reporting requirements that Skinner said will be key to understanding the state's seismic landscape.

"We'll get real-time data, which we don't have now because reports are prepared monthly on injection wells," Skinner said. "Now they will be reported daily, they will have digital monitors on certain classes of wells that are of the most interest and that will help a lot."

Hiding Studies?

Environmental groups in Oklahoma say the limited amount of information on earthquakes has hamstrung efforts to investigate their root causes.

"We believe the oil and gas companies in our state are not being forthcoming with valuable data that would help scientists investigate this swarm and regulators pass meaningful safeguards," David Ocamb, Oklahoma Sierra Club executive director, told Bloomberg BNA in a July 9 e-mail.

"Much like how big tobacco hid their health studies, we firmly believe the oil and gas industry is hiding information concerning induced seismicity,"Ocamb said.

"The Texas oil and natural gas industry agrees that recent seismic activity warrants robust investigation to determine the precise location, impact and cause or causes of these events."
Deb Mamula, Texas Oil & Gas Association

Oklahoma Independent Petroleum Association (OIPA) spokesman Cody Bannister told Bloomberg BNA in a July 11 e-mail that OIPA—representing 2,500 individuals and companies from Oklahoma's oil and natural gas industry—has formed a "working group" made up of its member companies, industry regulators and researchers "to ensure those regulators and researchers have access to industry data that may assist them" in their efforts in exploring the state's increased seismic activity.

Industry Supports Study

Responding to the study's central contention that the state's earthquake surge “is likely attributable” to subsurface wastewater injection at just a handful of disposal wells, OIPA President Mike Terry said in a statement that the association and the oil and gas industry “as a whole support the continued study” of the state's increased seismic activity.

“But a rush to judgment based on one researcher's findings provides no clear understanding of the causes,” he said.

“This is a moving target,” the OCC's Skinner said, referring to the ambiguity surrounding the source of the earthquakes. “We don't know enough yet to be able to do a rulemaking other than the rulemaking we've already done.”

“This is not an academic exercise in policy making for us,” Skinner said. “Our homes are cracking, our homes are shaking. The fact is that it's frightening. We are working as hard as we can, and we're devoting everything we can to this.”

Texas Quakes

In Texas, which has also faced unprecedented levels of seismic activity in its Fort Worth Basin, the state Legislature and the Railroad Commission of Texas (RRC) have moved to gather additional seismic information. However, Texas has stopped short of putting forth policy changes in response to induced seismicity.

The USGS identified 27 low-magnitude earthquakes beginning in November 2013 on the outskirts of Fort Worth, including a pair of earthquakes registering 3.6 in magnitude.

Only one earthquake was recorded in the basin prior to 2008, according to the North Texas Earthquake Group headed by seismologists at Southern Methodist University in Dallas. Since then, there have been 70, the group told state lawmakers.

‘Without Historic Precedent.’

“The current level of seismicity in the Fort Worth Basin is without historic precedent, just as is the much higher level of seismicity currently in progress in central Oklahoma and southern Kansas,” SMU seismologists Heather DeShon and Brian Stump told the state's inaugural hearing of the Special Seismic Activity Subcommittee of the House Committee on Energy Resources.

“All of these areas are places where recent changes in the production practices for oil and gas have resulted in the injection of large volumes of wastewater,” the study group said. “The possibility that they are related should not be dismissed so that improved practices for safe disposal of wastewaters can be developed and implemented.”

‘Not Happen Again.’

Alan Brundrett, mayor of Azle, a town of 11,220 that has seen more than 20 earthquakes since November 2013, told Bloomberg BNA in a July 9 e-mail that although injection wells triggering earthquakes are a rare occurrence, “we need to make sure it does not happen again in the future.”

Brundett said he would like to see “seismic monitoring of an area before a new injection well permit is issued.” He said he also would like to see “daily volumes and pressures of the wells provided to the RRC so the data could be linked if a seismic event were to occur.”

Disposal wells should be shut down if they affect the health and well-being of the community, he said.

No Shutdown Authority

The commission doesn't have the authority to shut down a well based “only on the presence of a nearby earthquake,” Gaye McElwain, a Railroad Commission representative, told Bloomberg BNA in a July 11 e-mail. McElwain said the commission's jurisdiction “generally” extends to threats of water pollution, without a specific allowance to seismic activity. A well could be shut down immediately if there is an indication of injection fluids escaping the disposal interval, she said.

“Our inspections in the 15-mile radius of Azle showed no indications that this was occurring,” McElwain said. “To date there has been no scientific proof that a specific well or wells caused the Azle-area earthquakes.”

Study Activity

Texas Railroad Commissioner David Porter said the RRC's seismologist would closely examine and study the state's seismic activity to achieve “an understanding of what, if any, human activity” induced the events.

“At this time, Railroad Commission of Texas staff has not identified a definitive correlation between seismic activity and injection wells or hydraulic fracturing in Texas,” said the RRC's McElwain.

The RRC's Porter told lawmakers, “It is imperative that the Commission base its rules and regulations on sound science and proven facts, not speculation and theories.”
The Railroad Commission permitted its first disposal well in 1936. Most of the state's wastewater injection wells are located in the Permian Basin in West Texas.
Town Hall
The RRC conducted a Jan. 2 town hall with Azle residents to listen to their concerns over seismicity. It announced April 1 the hiring of an in-house seismologist, David Craig Pearson, a Texas-educated geophysicist and former team leader for a Los Alamos National Laboratory seismic, experimental field team.
In a May 12 statement on the Texas Legislature's seismic activity hearing, the Texas Oil & Gas Association (TXOGA) said it is taking the issue of seismicity “very seriously,” saying it has “heightened its focus on disposal wells” and is “taking proactive steps” to mitigate risk related to seismic activity.
The oil and gas industry has also formed a Joint Industry Workgroup, a group TXOGA said “is in the process” of developing standards for considerations related to disposal well siting and seismic activity.
Cyrus Reed, conservation director of the Sierra Club Lone Star Chapter, said the science was clear enough to warrant the RRC's adoption of multiple rules designed to address seismicity concerns.
“We believe the commission should adopt rules requiring installation of portable seismic monitors around areas of high disposal activity,”Reed told Bloomberg BNA in a July 10 e-mail.
Additionally, he said, the commission should reopen a proposed rulemaking on injection wells and require a list of measures including: a seismic analysis of formations and surrounding areas; pre- and post-monitoring of seismic activity; specific permit limits related to the amount of fluid, depth of fluid, and type of formations; and requiring specific permit conditions to allow stoplight and mitigation measures.
RRC Authority
“While we believe the RRC has the authority to take all of these steps, when the Legislature convenes next year, they should still develop legislation giving the commission specific authorization to address seismic induction in its permitting of oil and gas disposal activities,” said Reed, who also called for the passing of legislation that authorizes the commission to consider seismic activity in all permitting issues, including in contested case hearings.
Additionally, Reed said the Legislature should empower the commission by giving it specific authority to suspend or terminate permits and activities that could lead to induced seismicity.
“These recommendations are not novel,” Reed said. “Portions of them have been implemented in several states, such as Ohio, Arkansas, Colorado and Oklahoma. By implementing these basic recommendations, Texas can make significant progress toward improving the well-being of affected communities and their private property.”
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For More Information

A map of the Arkansas permanent well disposal moratorium area is available from the state Oil and Gas Commission at http://www.aogc.state.ar.us/notices/Ex.%201B%20-Permanent%20Disposal%20Well%20Moratorium%20Area.pdf.

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